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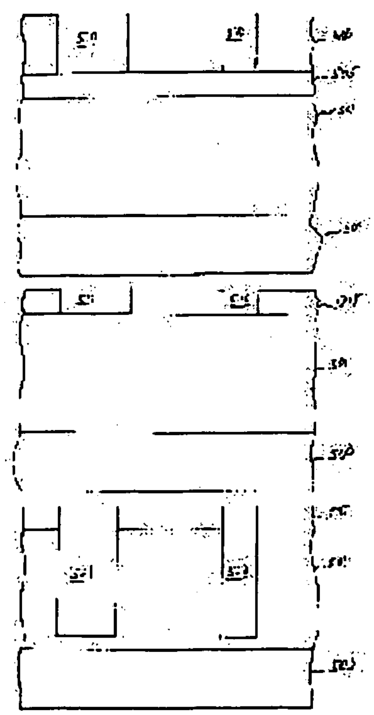
(54) OXIDE LAYER ETCHING METHOD



(57)Abstract:

PROBLEM TO BE SOLVED: To selectively etch an oxide layer with a plasma at a small side wall taper angle and low aspect dependency by using a hard mask layer for masking this layer.

SOLUTION: After forming an oxide layer 501 on a CVD nitride layer formed on the top face of a substrate 500, a poly-Si hard mask layer 505 is adhered onto that layer 501. Photoresist patterning layer 510 is adhered onto the mask layer 505 and patterned to form openings 511 and 512. The mask 512 is etched to form openings 515 and 516 into the mask layer 505 and then the patterning layer 510 is removed. The oxide layer 501 is plasma etched through the mask layer 505 to form openings 521 and 522 at nearly the same depth into the layer 501. Thus, an etching method is obtained which provides a high oxide to nitride selectivity with reduced ARDE effect.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the approach of forming opening in an oxide layer by etching in more detail about manufacture of a semiconductor device.
[0002]
[Description of the Prior Art] In manufacture of a semiconductor device, many electric conduction fields and conductive layers are formed in the interior or the front face of a semi-conductor substrate. The electric conduction field and conductive layer of these devices are mutually insulated by insulator like a silicon dioxide. A silicon dioxide can be made to grow up or deposit by physical deposition (for example, sputtering), or the chemical depositing method and a chemical reaction. Furthermore, a silicon dioxide can form Holin silicic-acid glass (BPSG) and Lynn silicic-acid glass (PSG), for example by doping boron, Lynn, or these both, if it can also form with no doping. Such the formation approach of a silicon-dioxide layer and doping of a silicon dioxide change with various conditions with the need of taking into consideration on each device and processing. Hereafter, in this application, all of the above silicon-dioxides layer are named a "oxide" layer generically.
[0003] In semiconductor device manufacture, it is some phases, and in order to enable contact and connection with a field or a layer with the bottom, it is required for an insulator to form opening. Opening to which an insulator is penetrated and a diffusion field is generally exposed, or opening which penetrates the insulating layer between polish recon and the 1st metal layer is called "contact opening", and opening in other oxide layers like opening which penetrates the insulating layer (ILD) between metals is called "Bahia." The vocabulary "opening" used by this application shall mean opening of all the gestalten formed in all kinds of oxide layer irrespective of the function of the layer exposed for a processing phase and processing, or opening.
[0004] In order to form opening, the patterning layer of the photoresist which has opening corresponding to the field of the oxide which is going to form opening is formed on an oxide layer. In the newest process, the dry etching method which puts a wafer to the plasma of the form of one or more sorts of gas streams is performed. Usually, as this etching gas, one or more sorts of halocarbon and/or one or more sorts of other halogen content compounds are used. For example, CF_4, CHF_3 (Freon 23), SF_6, and NF_3 And other gas can be used as etching gas. Furthermore, oxygen (O_2), an argon (Ar), and a gas like nitrogen (N_2) can also be added to the above-mentioned gas stream. Each specific gas mixture object actually used is determined by the desirable property about the property of the oxide to etch, the phase of processing, the etching tool to be used and an etch rate, wall inclination, an anisotropy, etc., for example.
[0005] In order to attain the above desirable etching properties, it divides and a gas mixture object, temperature, RF (high frequency) power, a pressure, and various etching parameters like a quantity of gas flow are changed. However, between the desirable properties of these versatility, a trade-off surely avoids and there is no ** and others. For example, etching of high performance presents the aspect ratio dependency etching effectiveness (the ARDE effectiveness) most. That is, the rate of oxide removal is

subordinate to the aspect ratio of opening which can be defined as the ratio of the depth of opening, and a diameter. The oxide etch rate generally expressed with the straight-line depth etched into unit time amount is farther [than the case where it is opening whose direction of opening of a low aspect ratio is a high aspect ratio] large. When it explains with reference to drawing 1 , a substrate 100 is a semi-conductor substrate with the oxide layer 101 bottom which etches and a certain device layer, or the structured division. For example, there may be a silicon nitride (Si3 N4) layer as a lower layer of an oxide layer 101. In this application, vocabulary called a silicon nitride layer or a nitride layer is used as a generic name of Six Ny (as for Ratio x:y, it is good not to be necessarily a stoichiometric ratio), and the acid silicon nitride (Six Oy Nz) film.

[0006] Like illustration, the patterning layer 110 which consists of a photoresist layer has openings 111 and 112. The diameter of opening 112 is farther [than the diameter of opening 111] small so that clearly from drawing. Since the thickness of the oxide layer 101 of these double door openings bottom is the same, and oxide layer opening under the photoresist opening 112 has the small diameter, it has a far larger aspect ratio than another opening. Consequently, as shown in drawing 1 , in the etching process of the conventional technique, the opening 121 in an oxide layer 101 will be completely etched before opening 122. In the conventional technique, adjusting the chemical property of feed gas, adjusting the operation pressure force, enlarging a pumping rate so that a high flow rate / low voltage operation may be possible, and adding dilution gas to a solving-problem of this aspect ratio dependency sake, is performed. However, when redesigning a process requires cost and time amount, the approach of making the aspect ratio dependency of the above conventional techniques as small as possible usually results in the trade-off between the ARDE effectiveness, and an etch rate, selectivity and other properties like profile control in many cases. Recently, compensating the ARDE effectiveness using a high density plasma (HDP) system is proposed. However, in real production mode, effectiveness is not proved and a considerable big cost of capital is still required for these HDP systems. If it becomes a more advanced technique, it should care about that the high etching engine performance is required in the layer which has a feature in the high etching engine performance is required by the high aspect ratio, and far-reaching. Thus, the ARDE effectiveness serves as a serious failure in an advanced applied technology.

[0007] Generally many etching properties are considered to be influenced of minus with the polymer residue put at the time of etching. It is thought for this reason that the fluorine pair carbon (F/C) ratio of the plasma is an important determinant in etching. Generally, the plasma which has a high F/C ratio has an etch rate quicker than the plasma of a low F/C ratio. a F/C ratio -- very much -- being low (that is, a carbon content being high) -- covering of a polymer takes place and etching stops. The etch rate as a function of a F/C ratio usually changes with ingredients. In order to perform selective etching using the difference of this etch rate, the attempt using a gas mixture object with which the F/C ratio of the plasma becomes the value which etching is not performed with another ingredient by etching being performed by one ingredient at a moderate rate, or polymer covering produces is made. Refer to [rather than] an S . wolf (S. Wolf) and R . N . TAUBA (R. N.Tauber) collaboration "siliconizing in the VLSI age" (1986 annual publications) Vol.1,539-585 page about detailed description about oxide etching.

[0008] By adjusting distributed gas, the taper of the side attachment wall of oxide opening is changeable. When the include angle of a low wall is desirable, the chemical property of distributed gas is adjusted so that a polymer may be made to deposit to some extent on a side attachment wall. On the contrary, when the include angle of a steep wall is desirable, the chemical property of distributed gas is adjusted so that the polymer deposition on a side attachment wall may be prevented. I hear that the important problem accompanying changing the chemical property of etching gas has a trade-off between the include angle of a wall, and selectivity, and it is in it. That is, by etching from which the include angle of the wall near 90 degrees is obtained, high selectivity is not usually acquired between an oxide, its lower layer silicon, or a silicon nitride layer, and if the selectivity of etching is high, the include angle of a wall will usually become low.

[0009] In drawing 2 , the oxide layer 201 is formed on the substrate 200, the patterning layer 210 is formed on it and opening 211 is formed in the patterning layer. The opening 221 in an oxide layer 201

shows the condition under formation. In etching shown in drawing 2 , in order [which is in the top face of a substrate 200 and is located down the etching part] to protect the field of silicon nitride, for example, high selectivity may be required. Moreover, it may be desirable to acquire a comparatively straight configuration. However, if it is going to maintain high selectivity, the opening 221 obtained as a result will become taper-like as angle 206 shows. In etching of the conventional technique in which permissible selectivity is secured, that it is smaller than 85 degrees often has angle 206. This trade-off becomes severe especially, when etching a thick oxide layer. For example, selectivity will become very low, if a process is designed so that a steep wall configuration may be secured into a thick BPSG layer. Although adjustment for improving the include angle of a wall by changing the chemical property of etching gas and other parameters etc. can be performed, considerable big effect will attain to all processes by trade-off of selectivity. Moreover, modification of such chemical property influences other performance objectives. For example, as stated above, it is thought that adjustment of a process parameter has considerable effect on the ARDE effectiveness. Furthermore, even if the adjustment point of an etching parameter which raises selectivity is found without having so large effect on the include angle of a wall, other trade-ofves will follow on such adjustment. For example, a trade-off is usually between selectivity and an etch rate, therefore increase of selectivity cannot be attained only in the sacrifice of a throughput. Although some adjustments can be performed so that he can naturally understand, it is very difficult to design oxide etching corresponding to all need targets. The general operation of process conditions of moreover [part] is known, and it can also understand existence of a fixed trade-off that it is not the problem of easy ****** to predict correctly the effect which etching of what can be predicted is fitted correctly or modification of a parameter does. Furthermore, preventing the effect which is not desirable as for others by polymer deposition often has a difficult thing.
[0010] Drawing 3 shows the effect of the polymer deposition in the etching process of the typical conventional technique. By the polymer deposited along the field 307 along the side attachment wall of opening 321, the wall configuration is the straight etching configuration shown with a broken line, and a different configuration. Moreover, etching of a part of nitride layer 302 is barred by polymer deposition of the field 308 in the core of the pars basilaris ossis occipitalis of opening. However, etching is performed around the rim section of the above-mentioned part. Configuration control of the wall of opening 321 becomes inadequate, and the nitride layer 302 of the pars basilaris ossis occipitalis of opening becomes thus, less uniform as a result of the process of the conventional technique. Although etching is also improvable by changing the chemical property of gas, and other etching parameters also in this case, a certain trade-off is unescapable. Furthermore, an oxide: When it is going to improve the selectivity of a nitride, the plasma state becomes less stable, when the composite quantity of a polymer increases and a reactor becomes dirty as a result, great maintenance is needed, or the yield often falls by generation of a particle.
[0011] It is very difficult to form opening in the square corner section of the semiconductor device structured division for a variety of difficulty in the above-mentioned oxide etching. In drawing 4 , alignment of the opening 411 of the patterning layer 410 is carried out so that it may be located above the structured division 404 which is the structured division of the gate, mutual wiring, electrode wiring, or others partially. The structured division 404 is covered with the etching stop layer 403 of silicon nitride like illustration. Usually, opening 421 is designed so that it may be partially located to some extent above the structured division 404. Before etching is completely performed to the pars basilaris ossis occipitalis of opening shown by 432, I hear that opening 421 reaches the square corner section of the structured division 404, and it is, as, as for having to take into consideration here, etching advances. Since it is difficult like illustration to perform high etching of selectivity very much, the structured division 404 reaches up 430, and the nitride layer 403 is removed from a flank 431, and the part will be put to considerable time amount etching, by the time etching reaches a pars basilaris ossis occipitalis 432. When the misdelivery-of-mail train of this problem is carried out to a location as opening 411 shows by broken-line 421a and it is formed in it, it is especially serious. Opening 421a has a small area in which the nitride layer 403 is exposed compared with the case of opening 421. Consequently, the part of the area to which the micro loading effect became small, therefore the nitride layer 403 became

narrow will be etched at a far quick rate.

[0012]

[Problem(s) to be Solved by the Invention] Therefore, from before, the ARDE effectiveness is small, and presents high oxide pair nitride selectivity, and the etching approach of oxide that management of a wall configuration is performed is searched for. furthermore, such an approach -- each -- the big trade-off among these performance objectives and among other performance objectives like an etch rate -- there is nothing -- this -- a side-attachment-wall taper -- small -- and -- or it is desirable that selective etching with the small ARDE effectiveness can be attained. Moreover, formation of opening located in other structured division top or the upper part must be possible for these approaches like etching of self-align contact. Finally especially these approaches can be dealt with formation of deeper opening, without formation of opening with the different deep depth making the engine performance a sacrifice too much in a required process step. And these approaches must be what can secure a trade-off of too much large-scale design change of a process or a process tool, engine performance, or process maintenance, and the etching properties expensive and above without installation of a non-proved facility, or a lot of particle generation.

[0013]

[Means for Solving the Problem] This application indicates the etching approach of opening like contact opening in an oxide layer, or Bahia opening. The approach of this invention is applicable to various etching including etching accompanied by opening which has a different aspect ratio, etching in the top face of the even structured division, and the top face of the shape of steep surface type, and etching that has these all further. In this invention, the ARDE effectiveness becomes small or it is lost, and oxide:nitride selectivity is improved, and the trade-off between selectivity and other performance objectives becomes very small, or it is lost. This invention sets like 1 operative condition, and the hard surface mask blank layer of for example, polish recon is used as a mask for oxide etching. The photoresist layer by which patterning was carried out so that the field of the hard surface mask blank corresponding to opening which it is going to form into an oxide layer might be exposed on the hard surface mask blank is formed. Next, the field of the hard surface mask blank exposed in this way is etched. According to this invention, the knowledge that the interaction of a photoresist mask (component considered to be carbon generated especially from a photoresist mask) and plasma etching gas did effect dominant in the aspect ratio dependency of etching was acquired. Therefore, it sets like 1 operative condition and a photoresist mask is removed before completion of oxide etching. When the interaction between a photoresist/etching gas was lost, the etching effectiveness of an aspect ratio dependency decreasing very much, or being lost was checked. Furthermore, the hard surface mask blank layer acted on etching gas and mutual, and the knowledge of being effective in improving oxide:nitride selectivity was acquired. In another embodiment of this invention, oxide etching is performed under an elevated temperature so that selectivity can be made high without the trade-off with the include angle of a wall.

[0014] In another embodiment of this invention, Freon 134a is used as an additive of etching gas so that oxide:nitride selectivity can be made high. In another embodiment of this invention, hard surface mask blank and Freon 134a and an elevated temperature are used so that oxide:nitride selective etching can be performed also to any of the shape of surface type of an even front face and the square corner section. In other embodiments of this invention, it is possible to perform etching at two steps. If it carries out at two steps when an oxide layer is thick, a high etch rate and selectivity will be possible and, moreover, the uniformity of a lower layer nitride layer will be secured. In an example of 2 step etching process, after a washing step removes a deposition polymer first, the 2nd etching step is performed. In another embodiment of this invention, etching is performed using a photoresist mask. A polymer puts this etching on a resist front face, and it is performed by [as also covering the side attachment wall of opening in the middle of formation further]. Thus, it does not act on the plasma and mutual, the aspect ratio dependency etching effectiveness becomes very small, or a photoresist mask is removed. Furthermore, etching gas brings about an improvement of oxide:nitride selectivity. Do not require separate hard surface mask blank covering or an etching step, they are carried out, and this etching can

be used also about the shape of surface type of the square corner section also in a flat configuration.
[0015] About the other descriptions and advantages of this invention, I will become clear by the publication of explanation of the following operation gestalten, a drawing, and a claim.
[0016] Although the operation gestalt which shows this invention to an accompanying drawing explains hereafter, these operation gestalten are the things for instantiation explanation, they do not restrict this invention and the same reference mark shows the same component or the same part in an accompanying drawing.
[0017]
[Embodiment of the Invention] The operation gestalt of the etching approach of an oxide layer is explained. In the following explanation, in order to aim at a perfect understanding of this invention, a specific ingredient, thickness, a processing step, a process parameter, etc. indicate many specific detail matters. However, probably, it will be clear to this contractor that it is not necessary to necessarily use in order for the detail matter of these specification to carry out this invention. Detailed explanation was omitted in order to avoid making this invention not clear superfluously about a well-known ingredient or a well-known approach in other cases. Furthermore, in the following explanation, some operation gestalten of this invention are explained in relation with opening of the specific structured division, an oxide layer, and an oxide layer. That it is not necessarily what is limited to the structured division and/or the oxide layer relevant to the explanation can understand each oxide etching approach which can use each approach explained into this application to various structured divisions and oxide layers, and can form opening of the configuration of arbitration, and is explained into this application. Furthermore, each approach explained into this application can also be carried out as a part of multi-step etching which consists of an additional etching process. Hereafter, the operation gestalt of some multi-step processes is explained.
[0018] Drawing 5 thru/or 7 show the structured division under manufacture of the semiconductor device by 1 operation gestalt of this invention. Drawing 8 shows the block diagram of the process performed about drawing 5 thru/or 7. First, as shown in the block 801 of drawing 8 , an oxide layer 501 is formed on the substrate 500 shown in drawing 5 . It may have the shape of surface type which a substrate 500 consists of a semi-conductor substrate containing for example, a device field, a layer, and the structured division, and has various change in the lower layer of an oxide layer 501. The vacuum evaporationo mold oxide as which what kind of oxide is sufficient and by which the growth mold oxide was also vapor-deposited by the approach of arbitration, such as CVD and spatter vacuum evaporationo, including what was doped, and a non-doped thing is sufficient as an oxide layer 501. It can understand an oxide layer 501 that you may be the multilayer-structure section which consists of the oxide layer of the class from which some differ. For example, in 1 operation gestalt, an oxide layer 501 consists of a 10,000A BPSG layer, and consists of some sub layers of the dopant concentration from which this BPSG layer itself differs, for example, and a 3000A non-doped oxide layer of the top face of a BPSG layer. In 1 operation gestalt, an oxide layer 501 is formed on the 900A CVD nitride layer on the maximum top face of a substrate 500. Next, in step 805 of drawing 8 , a hard surface mask blank is formed on an oxide layer. As shown in drawing 5 , the hard surface mask blank layer 505 is put on an oxide layer 501. In the case of 1 operation gestalt, the hard surface mask blank layer 505 consists of a polish recon layer vapor-deposited with the CVD method by the range of about 500-5000A thickness. It cannot be overemphasized that it is possible that the hard surface mask blank layer 505 can be put by the approach of well-known arbitration and to use thickness other than the above. furthermore -- as a hard surface mask blank -- silicon nitride, aluminum, and silicification -- probably, it will also be clear that the combination of the layer of classes other than the above of titanium, a tungsten, or other refractory metals or a layer can be used. Moreover, probably, the reason will be clear although it is desirable that they are non-carbon or the film with few carbon contents as for the hard surface mask blank layer 505.
[0019] In step 810, the patterning layer 510 which consists of a photoresist, for example is put on the hard surface mask blank layer 505, and as shown in drawing 5 , openings 511 and 512 are formed by carrying out patterning using the well-known approach. Probably, it will be clear that much opening other than illustration can be formed in such openings and coincidence which are shown in drawing over

the whole front face of a wafer. Next, in step 815, a hard surface mask blank is etched using the etching agent suitable for the ingredient which forms a hard surface mask blank 505, and the patterning layer 510 is removed in step 820. The structured division obtained after steps 815 and 820 is shown in <u>drawing 6</u> , and openings 515 and 516 are formed in the hard surface mask blank layer 505 like illustration. The diameter of opening 515 is more remarkably [than the diameter of opening 516] large, and the aperture ratio of opening 516 is large far from opening 515 so that clearly from drawing. As stated above, in the field of opening 516, an oxide etch rate usually becomes slow far according to an aperture ratio being large in this way. However, in this invention, this is avoidable by using a hard surface mask blank 505. Next, the structured division of <u>drawing 6</u> is applied to an oxide etching process in step 805, and opening is formed in the location of the oxide layer corresponding to the hard surface mask blank openings 515 and 516. <u>Drawing 7</u> shows the condition in front of the completion of etching of the openings 521 and 522 under etching to an oxide layer 501. Only the distance with the openings 521 and 522 almost same in an oxide layer 501 is etched so that clearly from drawing. Thus, by using a hard surface mask blank, the ARDE effectiveness becomes very small or is lost. Since it has the shape of surface type with change with various substrates 500 as stated above, the depth of opening in an oxide layer 501 may differ variously. Therefore, with the whole wafer, though all openings have the same diameter in such a case, when the depth of opening differs, an aspect ratio will change variously. Furthermore, both the diameters and depth of opening may differ from each other variously. or [that the hard surface mask blank of this invention reduces the aspect ratio dependency of etching in all these cases] -- or it is checked that it is removable.

[0020] Although use of a hard surface mask blank 505 is effective in all etching processes, 1 operation gestalt of this invention is carried out using the 384T dry etching system which are RIE / triode system. In the case of a wafer, 6" (150mm) of etching is performed in the etching gas style which consists of CHF3 (Freon 23) of Freon 134a for 2.5 standard cubic-centimeter/(SCCM), and 10SCCM(s). Moreover, this etching is performed under the DC bias of about 1400 volts (V) by 600W (W). The pressure at the time of etching is maintained at the range of about ten to 40 mTorr (milli toll). A lower electrode circulating water temperature is set as 17 degrees C, and upper chamber temperature is set as 50 degrees C. Although the above-mentioned etching was performed at after [removal] 1 step of a photoresist layer 510, after etching to the 1st part of an oxide layer first from a condition [etching at two steps, namely, not continuing not forming opening in the resist layer 510], it is failed to strip a photoresist, it leaves only the hard surface mask blank which defines the profile of opening next, and may be made to perform the last etching step of high performance. For example, in 1 operation gestalt, the non-selective etching step of a high etch rate designed so that a part of non-doped oxide layer and doped layer might be etched is performed first, and the 2nd etching step same next as the above is performed so that about 2000A oxide layer may remain in the thinnest part of a wafer. It is also possible to perform a washing step between two etching steps so that another operation gestalt of this invention may explain.

[0021] Use of the above hard surface mask blanks 505 is effective in all the present oxide etching processes. The ARDE effectiveness is considered to become the minimum by losing contribution of a receiving [this invention]-total carbon content of plasma photoresist. As stated above, the polymer residue formed from the carbon in the plasma has large effect on selectivity or an etching property like a wall configuration. However, it was not admitted that a photoresist layer does strong effect to an etching property like the ARDE effectiveness until now. Since the strong effect of such a photoresist is lost according to this invention, it is lost that selection of the chemical property of etching gas is restrained by the conditions of adjusting so that the ARDE effectiveness may serve as the minimum, and considerable process latitude is attained from the ability to adjust so that other performance objectives, such as an etch rate, selectivity, and profile control, may be attained rather. As stated above, it is thought that the advantage of this invention is attained by eliminating the interaction of the carbon and plasma etching gas which are produced from a photoresist and the photoresist which has the possibility most. Therefore, in other operation gestalten of this invention, it is possible to use the sensitization layer processed so that it might become inactive comparatively to plasma etching gas as an only masking layer. For example, the photoresist layer which was formed of the process known as a "DESIRE"

process and which silanized can be used. In this process, the exposed resist layer is processed with HMDS or the same compound, and silicon is sunk into each part of a resist layer. It is related with this. For example It is based on PABERUCHIEKU (Pavelchek) carried on 264-269 pages of vol.1925 (1993 one monthly publication) of SPIE. "the process technique for the engine-performance improvement of positive tone silanizing () [Techniques] ForImproving Performance of Positive Tone Silylation";, you . C . Berkeley (U. C.Berkeley), and C . A . Spence (C. A.Spence) of eye . BI . em Almaden research center (IBM Almaden ResearchCentre) **, Silanizing of "Pori (t-BOC) styrene resist of S . A . Macdonald (S. A.MacDonald) and dirty . SHUROSSA (H. Schlosser) collaboration: The engine performance and a mechanism () [Silylation Of] Poly(t-BOC) Styrene Resists:Performance and Refer to Mechanisms." Moreover, also refer to the bibliography quoted in these papers. The photoresist layer which was processed by this approach or the same approach as this and which seldom reacts with etching gas, therefore does not have big effect on the carbon content of the plasma can also be used instead of the hard surface mask blank layer explained by this application. In this case, the need does not have a patterning layer or hard surface mask blank layer which was described above, either. using a hard surface mask blank 505 -- or by making a sensitization layer inactive substantially to plasma etching gas, an established oxide etching process does not need to redo a design, or does not need to carry it out with new equipment etc., and can avoid many related trade-ofves, or can stop them to the minimum. In this invention, it can be made adapted without the problem of the carbon produced from the photoresist which has big effect on an etching property for the purpose of etching. Probably, it will be clear to the operation gestalt of this invention that the approach of improving oxide:nitride selectivity further, including the approach of making the minimum a trade-off of the include angle of selectivity/wall, the method of improving the selectivity in etching which needs opening [/ above the square corner section], and the approach of etching deep opening into an oxide layer are included. By using these approaches of this invention, it is also possible to be able to attain various performance objectives which were generally explained into this application, and to improve process latitude.
[00[illegible]] As everyone knows, in the etching approach of the oxide layer by the conventional technique, quite big heat occurs by the collision with the ion in the plasma and/or an electron, and a substrate. Moreover, it does in this way and the amount of the energy to generate is decided by various process parameters like the gas to be used or power. In order to prevent a extreme temperature rise, wafer temperature is cooled with both pouring a cooling agent like water to a lower electrode, passing gaseous helium on the background of a wafer, or the means of these. In a typical process, cooling is performed so that it may become the range whose maximum temperature of a wafer is about 60 degrees - 80 degrees C. Since it must fully cool so that the resist RECHIKYURESHON temperature which opening with resist temperature potential into the part designed by any so that, as for a wafer, a resist layer might also transform a case and a dimensional control might leave as a result, without [a disadvantage crack and] etching produces may not be exceeded, the upper limit temperature of a wafer is restrained by using the patterning layer of a photoresist. Typical resist RECHIKYURESHON temperature is about 110 degrees C. However, in this invention, as shown in drawing 6 , it should care about that a resist layer is removable before etching oxide. Therefore, in other operation gestalten of this invention, if temperature is required, it can also be adjusted beyond resist RECHIKYURESHON temperature (a background cooling agent style is adjusted appropriately). For example, in 1 operation gestalt performed using the above-mentioned etching system, it lowers even to about 2 Torr(s) (toll) which usually produce the helium flow rate of about one to 5 SCCM as compared with about 8 Torr(s) (toll) which usually produce the flow rate of about five to 15 SCCM in the case of the same process [pressure / which is passed on a background / helium] using a resist mask. By adjusting a helium pressure as mentioned above, it can be predicted that wafer temperature reaches the temperature of about 100 degrees - 200 degrees C or more. In 1 operation gestalt, wafer temperature is maintained at about 110 degrees - 130 degrees C. It should note that this temperature requirement is beyond the reticulated-ized temperature of the above-mentioned resist.
[00[illegible]] Drawing 9 shows the example of the opening 921 generally formed in the oxide layer 901 using the hard surface mask blank 505 and the same hard surface mask blank 905. What kind of oxide layer is

sufficient as an oxide layer 901. Generally, substrates 900 are a substrate 500 and same substrate, may have many layers and the structured division and may have the shape of surface type which has change in the opening bottom which it is going to form variously. a different diameter like the above-mentioned case -- having -- and -- or it is also possible to form two or more openings which have a different aspect ratio. Etching is performed using an above-mentioned helium flow rate and an above-mentioned pressure. Setting in 1 operation gestalt, etching is CHF3 of Freon 134a of about 1.5 SCCM(s), and about 47 SCCM(s). It carries out using the becoming etching gas style. Moreover, this etching is performed under the power of 600W, the pressure of 30mTorr, and the DC bias of about 1400 V. A lower electrode circulating water temperature is set as about 17 degrees C, and upper chamber temperature is set as 50 degrees C. The angle 906 using high temperature is larger than 85 degrees. This is contrastive as compared with the angle 206 of drawing 2 . If temperature is made high, it will be thought by controlling the polymer formation on an oxide side attachment wall in preference as compared with the pars basilaris ossis occipitalis of opening that the include angle of a wall is improved. Depending on the case, the include angle of a steep wall and an improvement of selectivity are found by this. In this invention, also when etching through the oxide layer of a different class like a doping layer and a non-doped layer, or the layer from which doping level differs variously, it is checked that configuration control is maintained. if temperature is generally made high -- all kinds of oxide -- other layers, especially a nitride -- "stickiness" -- being lost -- the silicon of an oxide, silicon nitride, and silicification -- it is thought that the high etch selectivity to titanium etc. is attained. Furthermore, the technique of improving a wall configuration without a trade-off of selectivity using such more high temperature is applicable to any processes which used the etching gas of arbitration. Since according to this invention selectivity is improved at higher temperature or it is maintained by the same level, bigger process latitude is obtained. For example, the selective etching of the layer of comparatively thick BPSG can be attained as the outstanding profile control is also. Furthermore, if temperature is made high, since an etch rate will generally increase, a throughput also becomes high. In addition to an improvement of the include angle of this wall, with the operation gestalt shown in drawing 9 , the advantage of the hard surface mask blank layer explained above is also attained.

[0024] In this invention, if Freon 134a is added to a certain etching gas, when not adding this, it is checked also in the etching gas which does not show oxide:nitride selectivity that oxide:nitride selectivity is improved. Chemical formula C two H2F4 of Freon 134a It is expressed. The structured division type of the molecule 1002 of Freon 134a is shown in drawing 10 A. In the operation gestalt explained here, it etches in the mixture containing Freon 134a and Freon 23 (CHF3). 1 operation gestalt -- setting -- CHF3 of about 1.5 flow rate SCCM(s) of Freon 134a about 47 flow rate SCCM(s), about ten to 40 pressure mTorr, and power 400 [about] -1200W and about 1000 -- it etches under the conditions of the DC bias of the range of -2000V. Reference of drawing 11 shows the oxide layer 1101 in the upper layer of the nitride layer 1102 on a substrate 1100. The substrate 1100 is the same as the above-mentioned substrate generally, and the oxide layer 1101 of it is the same as that of an oxide layer 501 generally. Opening 1111 is formed by carrying out patterning of the hard surface mask blank layer 1105, and etching it. Etching is performed like the above-mentioned case and the condition of the opening 1121 in an etching process is shown. Considerable polymer deposition is looked at by the side attachment wall 1130 of an oxide to a thing with very little polymer covering at a pars basilaris ossis occipitalis 1107 so that clearly from drawing.

[0025] Although the exact mechanism is unknown, it is thought that Freon 134a of this invention enables improvement in the above selectivity by decreasing the neutral fluorine (F) and fluorine ion which cooperated with the hard surface mask blank layer of polish recon, and separated, reducing such concentration in the plasma, and acting so that the F/C ratio in a nitride front face may be made small compared with an oxide front face by this. By it, etching becomes the situation that etching is hardly performed, on a nitride, although oxide etching is performed at the rate still permitted by this. Furthermore, it is thought that selectivity may become it high "To resemble existence of 3 chain molecules produced by the reaction of the molecule 1002 of Freon 134a and the carbon from other generation sources." Freon 134a is considered that the reaction shown in drawing 10 B is caused, and the

stable molecule 1005 is generated. Then, a molecule 1005 is CHF3. It is possible to react and to produce the 3 above-mentioned carbon molecules. Freon 134a is CHF3. The improvement of selectivity is checked when it is used. However, CHF3 Mixture of CH two F2 (Freon 32), CHF3 Mixture with CHF2 CF3 (Freon 125), and CHF3 C two F6 With mixture with Freon 116 Since it is checked that an improvement of selectivity like [at the time of using Freon 134a] is not found, it is thought that the 2nd hydrogen atom combined with the 1st carbon atom has a role important for the mechanism planned by this application.

[0026] An improvement of the selectivity by this invention is further considered that a part is attained by fluorine gettering operation of a hard surface mask blank. therefore, the hard surface mask blank 1105 -- desirable -- polish recon or silicon nitride, a tungsten (W), and silicification -- it considers as some kinds of other fluorine reactivity films, such as titanium (Ti Si). Of course, as for a hard surface mask blank 1105, it is still more desirable like the case of a hard surface mask blank 505 that they are non-carbon or very little film of a carbon content. It is checked that it is effective and can use with various processes and etching tools to variously different size with extensive addition of Freon 134a. Furthermore, the trade-off with other performance objectives is the minimum, or an improvement of selectivity is completely nothing and can be attained. Furthermore, the selectivity acquired by this invention can be attained, without [without it depends on the process which has the unstable plasma state and] being accompanied by a lot of polymer composition, therefore can avoid difficult problems, such as maintenance of a difficult reactor, particle generation, and a fall of wall configuration ******. About the present etching process gas, it is possible to change the addition of Freon 134a according to each specific situation. For example, what is necessary is just to usually add Freon 134a so that the flow rate of Freon 134a may turn into about 3 - 50% of the total quantity of gas flow.

[0027] It was often difficult to etch an oxide layer completely in many processes with high selectivity with the conventional technique in addition to the problem of wall configuration control, and it was difficult when it was especially deep opening. However, in this invention, since the carbon content from a photoresist is removed, it is possible by attaining the selectivity high without the problem of too much polymer deposition in a pars basilaris ossis occipitalis to etch opening completely. Moreover, in this invention, it is checked that the selectivity of infinity is mostly attained to a nitride for adhesion of a polymer in a nitride. That is, since a polymer begins to deposit after etching of a small amount takes place first, etching of a nitride is not maintained after etching of the first small amount irrespective of the die length of etching.

[0028] the difficulty of attaining oxide:nitride selectivity, as explained above with reference to drawing 4 -- in addition, there is difficulty also in attaining the uniformity of the nitride of further the bottom circles of contact, or a nitride etching stop layer being made not to be removed, either from the structured division 404. Drawing 12 thru/or 14 show other operation gestalten of this invention for solving this problem. In drawing 12 , the hard surface mask blank layer 1205 is formed on the oxide layer 1201. An oxide layer 1201 consists of a 2000A non-doped TEOS layer formed on the 12,000A BPSG layer in 1 operation gestalt. It is desirable that they are the polish recon or other fluorine gettering ingredients which were explained in relation to the hard surface mask blank 1205 and the hard surface mask blank 1105. A photoresist layer 1210 has opening 1211, and alignment of that opening 1211 has been carried out so that opening partially located above the structured division 1204 may be formed into an oxide layer (that is, etching must reach to the upper part of the square corner section in this case). For example, the process step shown in drawing 12 may be self-align contact etching. Next, in drawing 13 , the field of the hard surface mask blank 1205 exposed by opening 1211 is etched, and opening 1216 is formed. After forming opening 1216, a photoresist layer 1210 is removed.

[0029] In 1 operation gestalt of this invention, oxide etching is performed through a hard surface mask blank 1205 using the etching gas which consists of hot Freon 134a. In the case of 1 operation gestalt, etching is CHF3 of 10SCCM. It carries out by power 600W in the etching gas style which consists of Freon 134a of 2.5SCCM(s). The helium pressures by the side of a wafer are 2Torr(s). As mentioned above, oxide:nitride selectivity improves by **(ing) Freon 1348 with a hard surface mask blank 1205. By using high wafer temperature, it becomes controllable [the outstanding wall configuration], and

oxide:nitride selectivity is improved further, and the uniformity which excelled [front face / perpendicular on a level front face] in the nitride layer is secured. In addition to an improvement of selectivity, a hard surface mask blank 1205 also reduces the ARDE effectiveness. Although opening 1221 is formed in the oxide layer 1201 so that clearly from drawing 14 , the uniform part of the nitride layer 1203 remains in the structured division 1204, and the uniform part of the nitride layer 1202 remains in the pars basilaris ossis occipitalis 1230 of opening 1221. If the nitride layers 1202 and 1203 may be formed at the same processing step, that it may be formed at a different step can understand them. In 1 operation gestalt, the nitride layers 1202 and 1203 have the thickness of about 700A. In the case of the structured division as shown in drawing 12 thru/or 14, this invention has an improvement effect about the above-mentioned etching property. The high oxides above in this invention: Since nitride selectivity is attained, don't produce the problem of etching which reaches above the square corner section of the structured division explained in relation to drawing 4 . Furthermore, since the uniformity of a nitride is secured also on the front face where the square corner section is also even, this invention can be used in order to perform oxide etching with opening located above the square corner section, and opening located above the even front face. Furthermore, since a hard surface mask blank 1205 suppresses the ARDE effectiveness to the minimum, as for opening, aspect ratios may differ mutually. Moreover, it should note that such effectiveness does not moreover need to redesign an etching process substantially, and is attained by the present reactor technique. Also on the shape of changeful surface type, also on an even front face, the process window improved conventionally is obtained and, according to this invention, of course, larger process latitude is obtained in all kinds of etching.

[0030] It is possible to attain the deeper etching depth, without sacrificing the etching engine performance with the operation gestalt of further others of this invention. In drawing 15 , the patterning layer 1510 which has openings 1511 and 1512 is formed in the hard surface mask blank layer 1505 put on the oxide layer 1501. An oxide layer 1501 is a comparatively thick oxide which has the depth of the range of about 5,000-30,000A. Moreover, an oxide layer 1501 may consist of one sort of oxide layers of several layers, or two or more sorts of different oxide layers. For example, an oxide layer 1501 is about 3,000A CVD by which overall thickness is about 10,000A - 20,000A in 1 operation gestalt, and was formed on the one or more-layer BPSG layer. It consists of the maximum upper layer of a TEOS oxide. Usually, since deposition of a polymer arises at the pars basilaris ossis occipitalis of opening under formation, it is difficult to etch through such a thick layer. Furthermore, it is difficult to perform completely etching in which it has the aspect ratio from which opening differs, and a part of openings are located above the structured division for the reason mentioned above.

[0031] Therefore, in the operation gestalt of further others of this invention, as shown in drawing 15 , it etches so that openings 1516 and 1517 may be formed through the hard surface mask blank layer 1505. Next, although oxide etching is performed with a high etch rate, with the resist layer 1510 put, as for this etching, it is desirable to design so that one or more layers of the topmost part of an oxide layer 1501 may be etched. For example, in 1 operation gestalt, etching is carried out to the design which suited etching a part of non-doped layer and doped layer. In the case of 1 operation gestalt, etching is CHF3 of 70SCCM. It carries out in the etching gas style which consists of C two F6 (Freon 116) of 20SCCM(s). Moreover, this etching is performed by power 600W and pressure 50mTorr. A helium cooling agent pressure is set to 8Torr(s), and a lower electrode circulating water temperature is set as 17 degrees C. Next, a polymer removal step is performed. Ashing (ashing) is carried out for example, in the oxygen plasma, or a polymer can also perform wet chemical etching. For example, H2 SO4 and H2 O2 after an IPC barrel ashing system performs the washing step for [1st] 45 minutes by 400W in 1 operation gestalt using the oxygen (O2) style of 1.5Torr(s) It washes for 20 minutes in a solution. [150-degree C] When it is more desirable, polymer washing may be performed at one step as well as one step in the above. Furthermore, probably, it will be clear that it is possible to perform the washing step of the same many. The patterning layer 1510 is also removed in a polymer removal step.

[0032] Drawing 16 performs the above-mentioned step and shows the structured division of drawing 15 after forming opening 1521' and 1522' partially. The considerable thickness part of an oxide layer 1501

is removed by etching so that clearly from drawing. Furthermore, all polymers are removed from opening. Next, the one etching approach of this invention using Freon 134a and the elevated temperature which were explained by drawing 12 thru/or 14 above is performed. The structured division of drawing 16 after the 2nd etching step is shown in drawing 17 . Like illustration, openings 1521 and 1522 penetrate an oxide layer 1501 completely, and arrive at the front face of the nitride layer 1502. The nitride layer 1502 is in the pars basilaris ossis occipitalis of opening, and is maintained at the uniform condition. Moreover, the nitride layer 1503 on the structured division 1504 maintains a sound condition. As mentioned above, etching temperature is changeable according to a desired taper. For example, the 85 degrees - 90 degrees angle 1506 can be formed by lowering the flow rate and pressure of helium so that wafer temperature may become high, as explained above. Or if required, the usual cooling can also be performed so that the taper of angle 1506 may become 85 degrees or less.
[0033] As stated above, use of the hard surface mask blank in an oxide etching process has the effectiveness which prevents the interaction of a photoresist and etching gas. By forming the structured division as shown in drawing 13 , various etching gas and various etching conditions can be investigated, and polymer formation in case there is nothing about the interference from the bottom of those conditions and a photoresist can be observed. For example, it was checked that polymer deposition takes place into an etching process to the bottom of some conditions on the level front face in which it is located at the top face of a hard surface mask blank like a hard surface mask blank 1205. In the conventional technique, although the polymer deposition on the nitride front face in a side attachment wall and opening and the base of a trench was known, the polymer deposition in a top face like the top face of the layer 1205 of drawing 13 was not known. This is because sufficient ion bombardment for the level front face on a top face to prevent polymer formation is received. On the other hand, the structured division in the side attachment wall of opening and a side attachment wall has few ion bombardments to receive remarkably.
[0034] Therefore, in the operation gestalt of further others of this invention, a photoresist mask is used under the conditions in which formation of the polymer film occurs on the top face of a hard surface mask blank. The substrate 1800 with which the structured division 1804, the nitride layer 1802, and the oxide layer 1801 were formed is shown in drawing 18 . Although such layers and structures are the same as that of what was explained by drawing 12 generally, they may be the same as the layer or structure where it explained in connection with other operation gestalten of this invention. On an oxide layer, a sensitization layer like the positive form photoresist layer 1810 is formed. In the case of 1 operation gestalt, the sensitization layer has the thickness of the range of about 1.0-1.5 microns. Opening 1811 is formed in the photoresist layer 1810 by the well-known approach. A photoresist layer 1810 can be used as a mask for forming contact opening or Bahia in the field of the oxide layer 1801 exposed by opening 1811.
[0035] In 1 operation gestalt of this invention, etching is performed in a LAM384T dry etching system. It sets to a certain system designed as an object for 8 inch wafers, and is CHF3 of Freon 134a of 3SCCM, and 10SCCM(s). It etches in the becoming etching gas. this etching -- power 300 [about] -- the range of -400W -- desirable -- about 350 -- it carries out under about 1200-volt DC bias by W. 1 operation gestalt -- setting -- the range of about 20 to 50 mTorr -- it etches under the pressure of about 35 mTorr(s) preferably. Moreover, a helium pressure is set to about 1.5 Torr(s) which usually produce the helium flow rate of the range of about one to 2 SCCM in 1 operation gestalt. By this helium flow rate, it can be predicted that a wafer reaches the temperature of about 90 degrees C. Since this temperature must maintain temperature below at resist reticulated-ized temperature mostly, it is below temperature used with some operation gestalten of this invention using a hard surface mask blank.
[0036] Furthermore, some change was made to the etching system. For example, in this system, the grid construction made from aluminum which has two or more openings is arranged between an up electrode and a lower electrode. At the time of etching, this grid may impress an electrical potential difference, or may ground it as in 1 operation gestalt. The typical opening dimension of a grid is about 9mm. However, the opening dimension of about 15mm is used in 1 operation gestalt. If still larger opening is used, an umbra will become small and the more intense plasma will arise. furthermore, 1 operation

gestalt -- setting -- an electrode spacing -- the range of about 1.3-1.8 inches -- it could be about 1.6 inches preferably. This spacing is larger than about 0.6 inches which is the electrode spacing of the typical conventional technique. Finally, in 1 operation gestalt, it changed to the standard roots-blower mold mechanical pump, and the turbine pump was used, and the pumping duct was changed into 3 inches from 2 inches so that it could respond to a larger pumping rate. Usually, these modification can set a pressure constant and can respond to a bigger quantity of gas flow (for example, about 4 times).

[0037] Next, drawing 19 shows the substrate of drawing 18 after the above-mentioned etching process initiation. Like illustration, the thin layer 1901 of a polymer is formed on the top face of the resist layer 1810, and the side attachment wall of opening 1811. This polymer covering layer confines a resist layer substantially so that a resist / interaction between plasma may be prevented. By this containment, since the etching velocity ratio of an oxide:resist becomes infinite substantially, a resist mask is maintained at the condition of not being eaten away among an etching process. Although polymer deposition takes place to the top face of the resist layer 1810, etching of the field exposed by the opening 1811 of an oxide layer 1801 is performed by continuing. Neutrality [in / in the front-face top of the resist layer 1810 / the plasma of this invention]: Although it is thought that polymer deposition takes place according to increase of an electrification ion ratio, it is thought that polymer formation/deposition occurs on the front face of the resist layer 1810 according to other factors similarly. Although it is clear that these conditions lead to the polymer deposition on the front face of the hard surface mask blank formed by layer like the resist layer 1810 or polish recon, as compared with those of these other than an oxide layer, substantial polymer deposition does not take place to an oxide layer under existence of high neutral flux (flux) for the reactivity of the oxide layer under existence of an ion bombardment.

[0038] Usually, in the conventional technique, although the polymer formation on the side attachment wall of opening 1811 may happen as stated above, the polymer deposition in the top face of a resist layer does not take place. Therefore, in the conventional technique, a resist is etched at the rate of the finite which exists for an ion bombardment. Furthermore, the square corner section usually carries out the pull back slightly as a resist layer is etched. For example, a broken line 1905 shows etching of the photoresist layer 1810 near the opening in the process of the conventional technique. Finally, as for the pull back of this square corner section, opening with a very large taper may be produced as etching progresses. On the other hand, in this invention, since the top face of a layer 1810 is reached and a polymer layer 1901 is in the side attachment wall of opening 1811, similar maintenance of the resist configuration is carried out. Furthermore, since it is maintained without eating a resist away, it is also possible to perform etching which lets a comparatively thick oxide layer pass.

[0039] The condition after the completion of etching of the substrate of drawing 19 is shown in drawing 20 . Like illustration, a polymer layer 1901 confines the sensitization layer 1810, and also adheres to the side attachment wall of the nitride layer 1802 and an oxide layer 1801. The polymer deposition on a side attachment wall usually originates in the ion bombardment of a side attachment wall being comparatively small in part, as mentioned above. Moreover, as stated above, the amount of the polymer deposited on the side attachment wall of oxide like a side attachment wall 1801 is subordinate to process conditions especially temperature, and etching gas. In 1 operation gestalt, although a polymer layer 1901 is produced on a side attachment wall 1801, the temperature of the above-mentioned operation gestalt is sufficiently high temperature as the include angle of a permissible wall is obtained. Furthermore, the oxide which the etching gas of this operation gestalt made produce polymer deposition in preference on a nitride front face, and was excellent as mentioned above: Nitride selectivity is acquired. By formation of the polymer layer 1901 on the nitride layer 1802, since etching of the nitride layer 1802 does not take place on the top face or side face of the structured division 1804, the square corner section of the structured division is maintained, while not having been eaten away by it. Therefore, it is possible like the case of other operation gestalten of this invention to maintain high selectivity also in deep etching in a thick oxide layer even in the upper part of the square corner section of the structured division.

[0040] It is advantageous to use the process explained in the example shown in drawing 18 thru/or drawing 20 at the point that there are no polymer deposition and etching in a hard surface mask blank, removal of a photoresist is unnecessary and there is also no washing step in the operation gestalt using

the hard surface mask blank explained above. Thus, if a polymer deposition method is used, many advantages of the operation gestalt of a hard surface mask blank will be secured in the process which is not cheaper and complicated.

[0041] As stated above, a polymer deposition method is found out by using the operation gestalt of the hard surface mask blank which does not use a photoresist at first. Thus, the deposition property of a polymer of not causing an interaction with a resist can be searched for by experiment etc. Since a resist / interaction between plasma will be instantly prevented if the conditions of a lot that the polymer deposition on the level front face on a top face once takes place are found, and polymer deposition takes place, it is possible to use those conditions with the operation gestalt which has a photoresist mask. According to the above-mentioned etching parameter, although the containment of a resist layer is possible, it cannot be overemphasized that it is possible to use other process conditions including reduction or prevention of the aspect ratio dependency effectiveness which produce the containment of the resist which leads to the advantage of this invention according to the guide explained below.

[0042] If it is this contractor, it is possible by forming the structured division as shown in drawing 13 to adjust the chemical conditions of etching gas, power, time amount, and an equipment configuration so that specific equipment and the specific process step which have been set as the object of an interest may be suited. For example, in 1 operation gestalt, as mentioned above, numerical aperture in a grid was made [many]. According to this, the more efficient plasma is acquired and the non-charged chemical species in the plasma increase. Consequently, compared with the plasma with high ion flux, the plasma with the strong operation which makes a polymer deposit on the front face of the resist layer 1810 arises rather than the operation which produces etching of a resist is more strong. Furthermore, when an electrode spacing is enlarged by keeping away a wafer from plasma discharge slightly, there is the same effectiveness as making small ion flux in a resist front face. Thus, if it is this contractor, while adding adjustment to equipment using these consideration matter and conditions and making a polymer deposit on a resist layer, it is possible, when required to acquire plasma which etches an oxide layer. Furthermore, together with correction of such equipment, adjustment of etching gas or other process parameters may be replaced with correction of equipment, and may be performed. For example, it is Freon 134a, CHF3, and H2 as the well-known approach that it is known that the amount of polymer generation will increase. It is also possible to raise the concentration of one or more sorts of etching gas [like].

[0043] a group permissible without a resist layer about 1 operation gestalt which uses a hard surface mask blank as stated above -- conditions can be searched for. Some small adjustments were performed to the operation gestalt of the hard surface mask blank used in order to description-ize a process about this as compared with the conditions explained in relation to drawing 18 thru/or the operation gestalt of 20. For example, the operation gestalt using the resist layer 1810 was carried out by the high pressure about 5 mTorrs from the process description-ized with the operation gestalt using a hard surface mask blank. Furthermore, the temperature of the operation gestalt of drawing 18 thru/or the resist layer of 20 is more slightly [than the description-ized process of a hard surface mask blank] low. Generally, since a photoresist layer is about 5 times as thick as a hard surface mask blank layer, these corrections and modification increase the neutral ion flux in opening, and they are performed in order to make the polymer deposition in opening maintain. If temperature is lowered to overall polymer flux increasing if a pressure is made high, polymer adhesion of a side attachment wall will increase. Of course, as stated above, temperature should not be made high even if smaller than resist reticulated-ized temperature. As it mentioned above, in order to make a quantity of gas flow increase, the system of an operation gestalt was corrected, but probably, such correction will usually be unnecessary, since it is thought that pump rate sufficient with an ordinary mechanical pump is obtained.

[0044] In the above, the etching approach of the oxide layer by this invention was explained to the detail. In this application, although specific equipment, the parameter, the approach, and the specific operation gestalt containing an ingredient were explained, probably, for this contractor, various modification and the correction mode to the operation gestalt indicated by this application will be obvious. Therefore, these operation gestalten are only the things for instantiation explanation, this

invention of a wide sense is not restricted, and it is not limited to the specific operation gestalt which this invention indicated to this application, and was explained.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The step which prepares the substrate for supporting ** and the above-mentioned oxide layer for the approach of etching an oxide layer, The step which forms a sensitization layer on the above-mentioned oxide layer, the step which forms the 1st opening for exposing a part of above-mentioned oxide layer in the above-mentioned sensitization layer, and the above-mentioned substrate are put to the plasma. By the plasma The approach which possesses the step which forms the 1st layer on the above-mentioned sensitization layer while etching the part of the above-mentioned oxide layer exposed at the above-mentioned step.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline sectional view showing aspect ratio dependency etching of the oxide etching process of the conventional technique.
[Drawing 2] It is the outline sectional view showing the wall configuration in the oxide etching process of the conventional technique.
[Drawing 3] The low oxide in the etching process of the conventional technique: It is the outline sectional view showing the example of nitride selectivity.
[Drawing 4] It is the outline sectional view showing the etching process of the conventional technique in the upper part of a certain structured division.
[Drawing 5] It is the sectional view of the structured division which has the hard surface mask blank of 1 operation gestalt of this invention.
[Drawing 6] It is the sectional view showing the structured division of drawing 5 after etching of a hard surface mask blank.
[Drawing 7] In 1 operation gestalt of this invention, it is the sectional view showing the condition in front of completion of oxide etching performed to the structured division of drawing 6 .
[Drawing 8] It is the block diagram showing the step used in the process shown in drawing 5 thru/or 7.
[Drawing 9] It is the sectional view showing the result of oxide etching by 1 operation gestalt of this invention.
[Drawing 10] It is the explanatory view (B) showing the reaction considered to happen by the explanatory view (A) showing the molecular structure section of the etching agent used with 1 operation gestalt of this invention, and the molecule of (A).
[Drawing 11] It is the sectional view showing the result of oxide etching using the etching gas which consists of an etching agent shown in drawing 10 .
[Drawing 12] It is the sectional view of the structured division which is going to perform oxide etching by 1 operation gestalt of this invention.
[Drawing 13] It is the sectional view showing the structured division of drawing 13 after etching of the hard surface mask blank of 1 operation gestalt of this invention.
[Drawing 14] It is the sectional view showing the structured division of drawing 13 after oxide etching by 1 operation gestalt of this invention.
[Drawing 15] It is the sectional view showing the structured division considered as etching use in 1 operation gestalt of this invention.
[Drawing 16] It is the sectional view showing the structured division of drawing 15 after the 1st etching step and a washing step.
[Drawing 17] It is the sectional view showing the structured division of drawing 16 after the 2nd etching step.
[Drawing 18] It is the sectional view showing the structured division which it is going to etch in another operation gestalt of this invention.
[Drawing 19] It is the sectional view showing the structured division of drawing 18 during etching.

[Drawing 20] It is the sectional view showing drawing 18 at the time of completion of etching, and the structured division of 19.
[Description of Notations]
500 A substrate, 501 An oxide layer, 505 A hard surface mask blank layer, 510 511 A patterning layer, 512 Opening.

[Translation done.]

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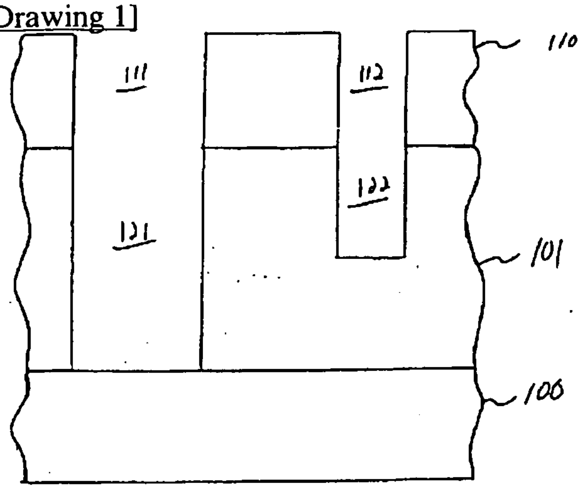
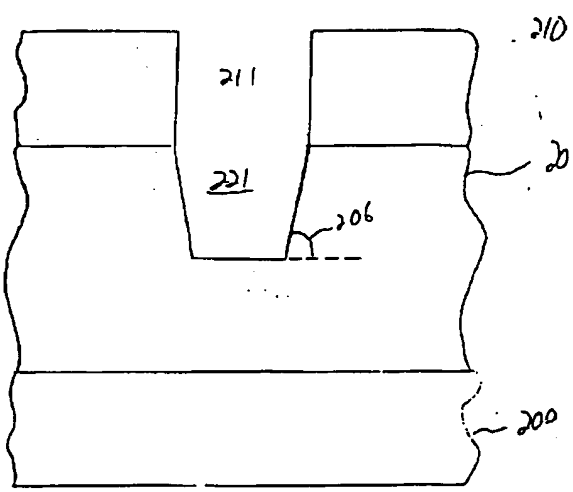
3.In the drawings, any words are not translated.

DRAWINGS

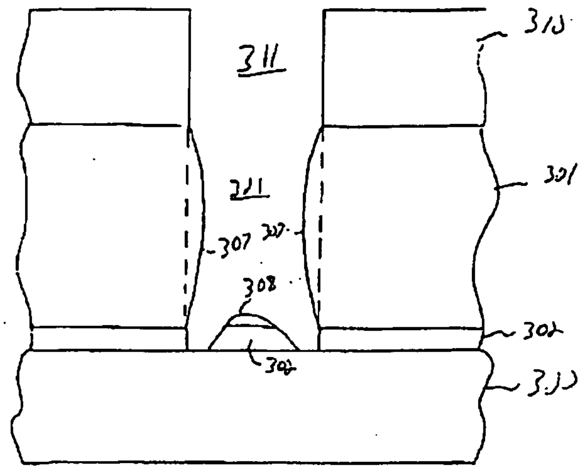
[Drawing 1]



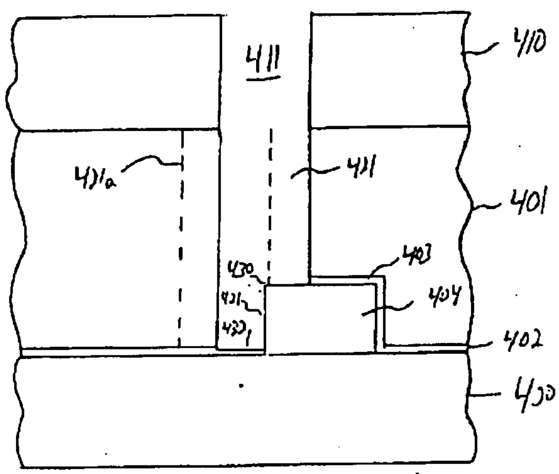
[Drawing 2]



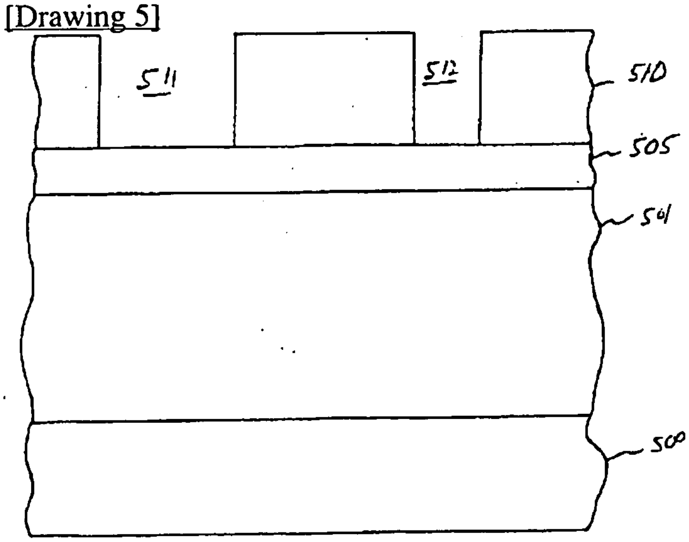
[Drawing 3]



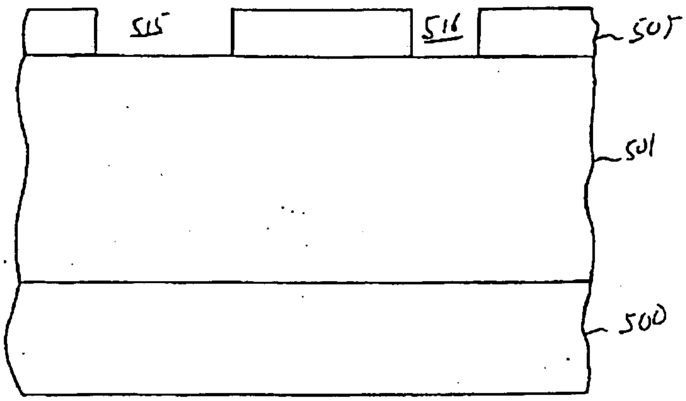
[Drawing 4]



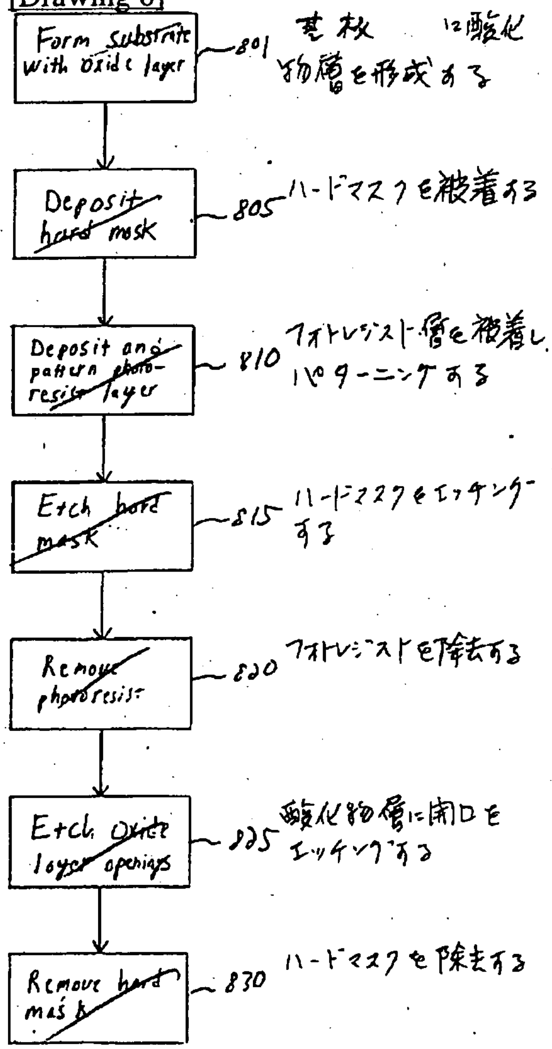
[Drawing 5]



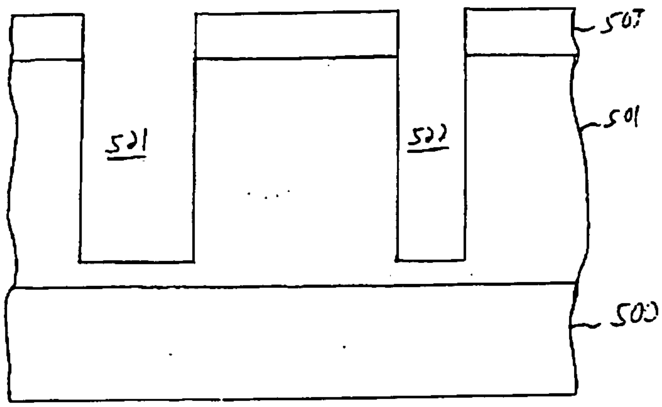
[Drawing 6]



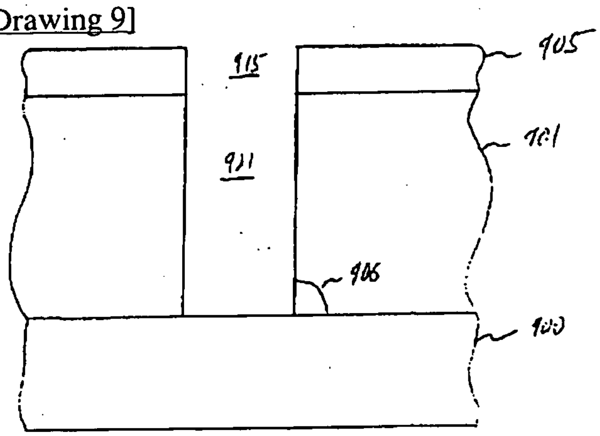
[Drawing 8]



[Drawing 7]

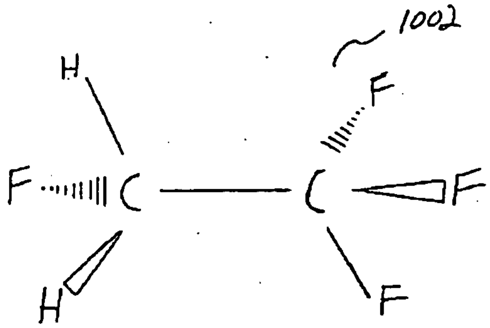


[Drawing 9]

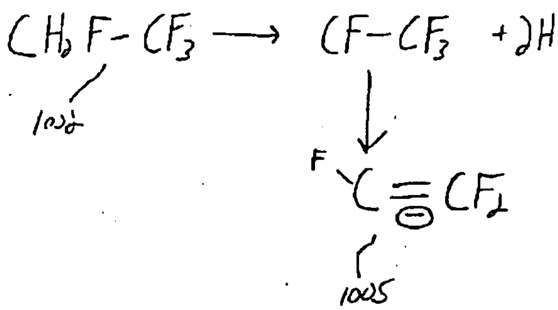


[Drawing 10]

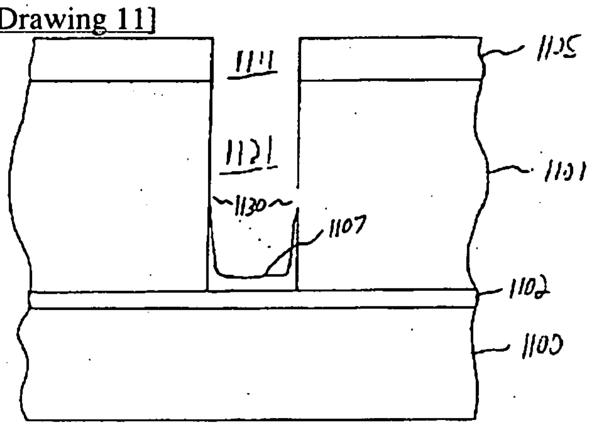
A



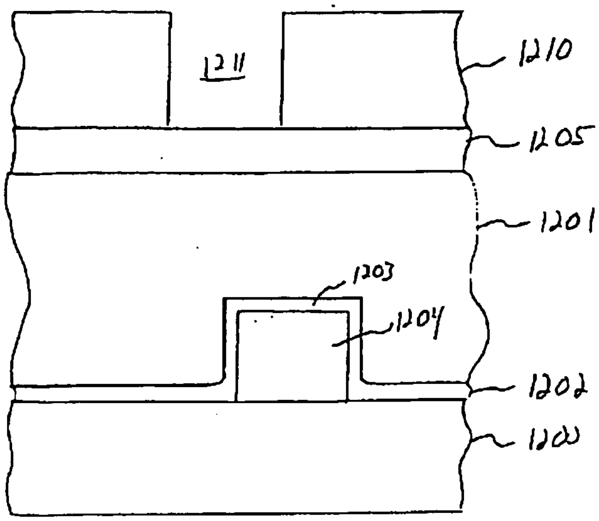
B



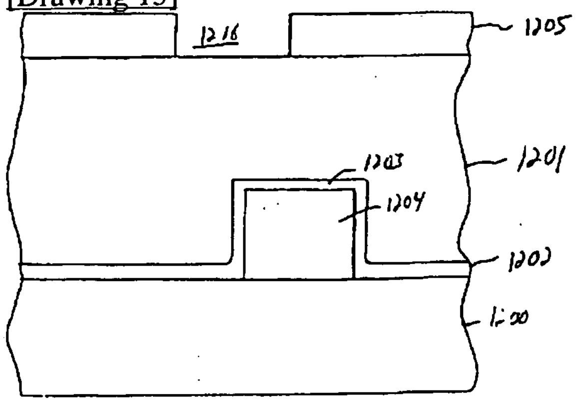
[Drawing 11]



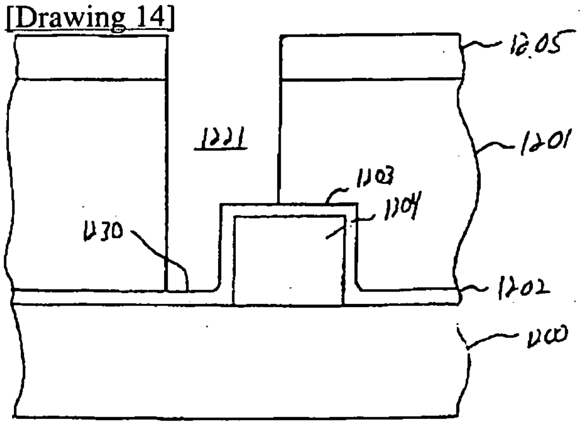
[Drawing 12]



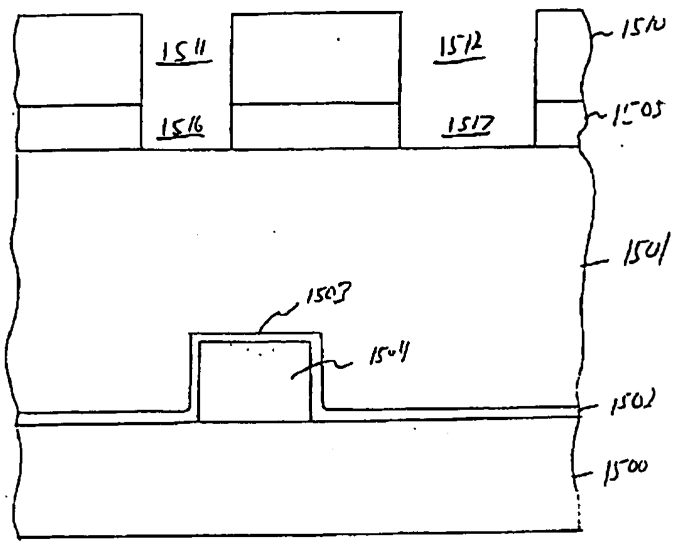
[Drawing 13]



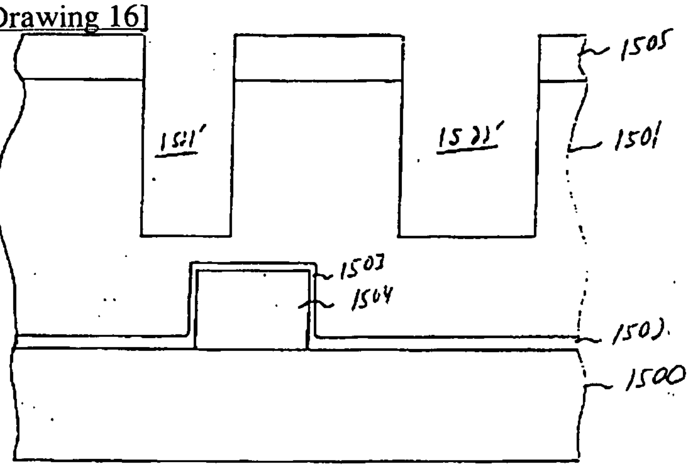
[Drawing 14]



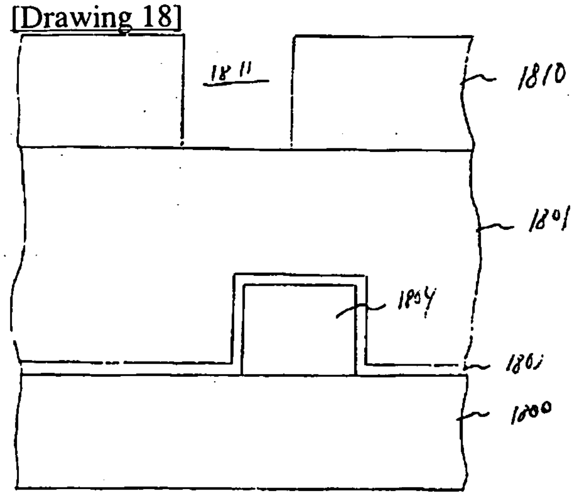
[Drawing 15]



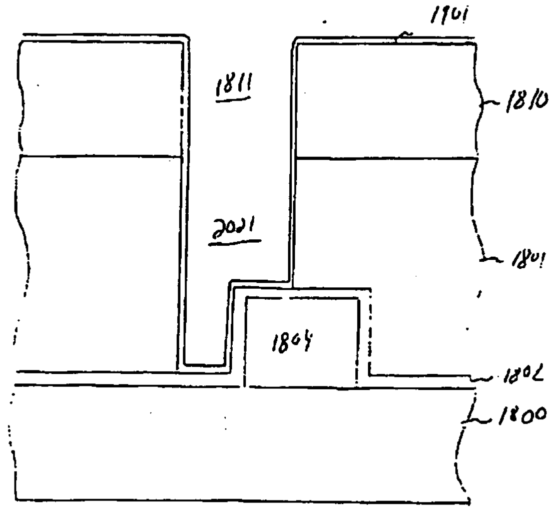
[Drawing 16]



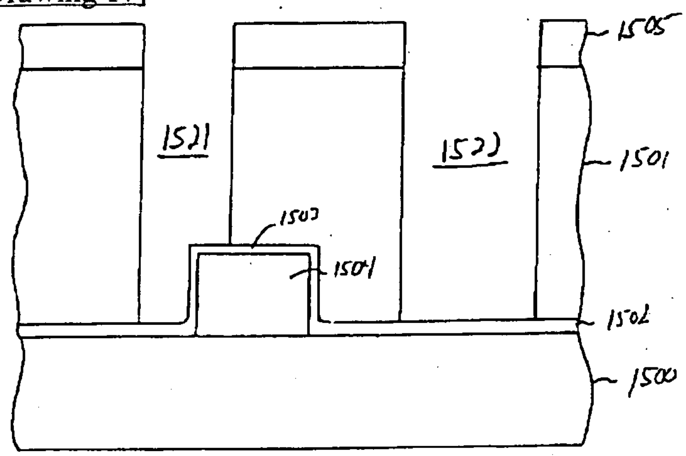
[Drawing 18]



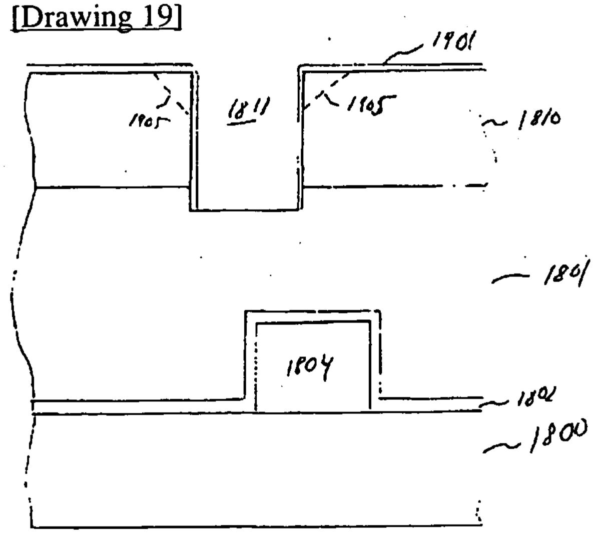
[Drawing 20]



[Drawing 17]



[Drawing 19]



[Translation done.]